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FINAL REPORT, NASA CONTRACT NAGW-1216
"Theoretical and Photometric Analysis of Water Volcanism on the Moons of Uranus"

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Summary of research program

The original intention of this research program was (a) to continue the development of existing photoclinometric techniques and to explore new techniques so that (b) they could be applied to the Voyager 2 images of the icy satellites of Uranus to deduce topographic and albedo data for features suspected to be the products of water volcanism; and (c) to continue a long-standing program of development of theoretical models of eruption processes on small bodies which could be applied to the available data.

In the event, the rate of systematic release of Voyager images together with the support data needed for their radiometric calibration (which is essential for photoclinometry) was much slower than anticipated during the period covered by this grant. As a result, the theoretical developments under sub-headings (a) and (c) proceeded well, whereas little could be accomplished under sub-heading (b). By the time the relevant data were available, during the final year of the grant period, other NASA-funded groups had begun to make similar albedo and topography measurements to those planned here, and it was judged more appropriate in the time available to round out the theoretical work than to duplicate the work of others. The consequence is that the products from this research program largely consist of general theoretical developments related to volcanic processes which are mostly tested by application to other data sets and target bodies than those originally intended. However, the potential for applying them to the Uranus satellites still exists.

The theoretical developments accomplished under this program were concentrated towards understanding the following issues:

(1) the theory of photometry as applied to photoclinometric topography determination;

(2) the conditions under which partial melts are stored in reservoirs before being erupted to the surface of a planetary body;

(3) the shapes, sizes and orientations of the brittle fractures through which melts migrate inside planetary bodies;

(4) the dynamics of melt transfer from storage zones at depth to eruption sites at the surface of a body;

(5) the dynamics and morphologies of melt flows on planetary surfaces as a function of the rheology of the melt being erupted;

(6) the eruption styles at planetary surface vents as a function of the magma volatile content, and the planetary gravity and atmospheric pressure;

(7) processes expected to modify the initial morphologies of topographic features on the surfaces of small solar system bodies.

A list of the published work supported wholly or in part by this grant follows. The number in parentheses following each entry indicates to which of the above categories it belongs.

Publications resulting from this program (chronological order)

Journal Papers:

Wilson, L., Lawson, R., Efford, N.D. & Young, P.C. (1988) Determination of topography using photoclinometry. **ESA Special Publication 284**, 429. (1)

Wilson, L. and Head, J.W. (1988) Nature of local magma storage zones and geometry of conduit systems below basaltic eruption sites: the Pu'u 'O'o, Kilauea East Rift, Hawaii example. **J. geophys. Res. 93**, 14785-14792. (3)

Head, J.W. and Wilson, L. (1989) Basaltic pyroclastic eruptions: influence of gas-release patterns and volume fluxes on fountain structure, and the formation of cinder cones, spatter cones, rootless flows, lava ponds and lava flows. **J. Volcanol. geotherm. Res. 37**, 261-271. (6)

Giberti, G. and Wilson, L. (1990) The Influence of geometry on the ascent of magma in open fissures. **Bull. Volcanol. 52**, 515-521. (4)

Wilson, L. and Keil, K. (1991) Consequences of explosive eruptions on small Solar System bodies: the case of the missing basalts on the aubrite parent body. **Earth planet. Sci. Lett. 104**, 505-512. (6)

Head, J.W. and Wilson, L. (1991) Absence of large shield volcanoes and calderas on the Moon: consequences of magma transport phenomena? **Geophys. Res. Lett. 18**, 2121-2124. (4)

Wilson, L. Head, J.W. and Parfitt, E.A. (1992) The relationship between the height of a volcano and the depth to its magma source zone: a critical reexamination. **Geophys. Res. Lett.** (accepted). (3)

Parfitt, E.A., Wilson, L. and Head, J.W. (1992) Basaltic magma reservoirs: factors controlling their rupture characteristics and evolution. (submitted to **J. Volcanol. geotherm. Res.**). (2)

Extended Abstracts

Efford, N.D. and Wilson, L. (1988) Photometric characterisation of the lunar surface using Hapke's equation. **Lunar & Planetary Sci. XIX**, 295-296. (1)

Parfitt, E.A. and Wilson, L. (1988) Episodic magma motion in shield volcano rift zones. **Lunar & Planetary Sci. XIX**, 903-904. (3)

Pinkerton, H. and Wilson, L. (1988) The lengths of lava flows. **Lunar & Planetary Sci. XIX**, 937-938. (5)

Wilson, L. and Head, J.W. (1988) The influence of gravity on planetary volcanic eruption rates. **Lunar & Planetary Sci. XIX**, 1283-1284. (4)

Wilson, L. and Head, J.W. (1988) Phobos surface morphology and its relation to surface and internal processes: a preliminary assessment. Abstract for meeting of the **International Scientific Council of the Phobos Project**, Space Research Institute, USSR Academy of Sciences, Moscow. (7)

Efford, N.D. (1989) Photometric techniques for the analysis of satellite surfaces. **Lunar & Planetary Sci. XX**, 262-263. (1)

Parfitt, E.A. (1989) Theoretical constraints on the location of eruptions and intrusions of planetary volcanoes: data from Kilauea volcano, Hawaii. **Lunar & Planetary Sci. XX**, 824-825. (4)

Wilson, L. & Parfitt, E.A. (1989) The influence of gravity on planetary volcanic eruption rates: a reappraisal. **Lunar & Planetary Sci. XX**, 1213-1214. (4)

Wilson, L. and Head, J.W. (1990) Factors controlling the structures of magma chambers in basaltic volcanoes. **Lunar & Planetary Sci. XXI**, 1343-1344. (2)

Wilson, L. and Keil, K. (1991) Explosive eruptions on asteroids: the missing basalts on the aubrite parent body. **Lunar & Planetary Sci. XXII**, 1515-1516. (6)

Wilson, L., Parfitt, E.A. and Head, J.W. (1991) The relationship between the height of a volcano and the depth to its magma source zone: some popular misconceptions. **Lunar & Planetary Sci. XXII**, 1517-1518. (3)

Efford, N.D. and Wilson, L. (1991) Theoretical aspects of photoclinometric terrain profiling on Phobos and other bodies. **Lunar & Planetary Sci. XXII**, 341-342. (1)

Pinkerton, H. and Wilson, L. (1992) The dynamics of channel-fed lava flows. **Lunar & Planetary Sci. XXIII**, 1083-1084. (5)